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R&D

Research & Development

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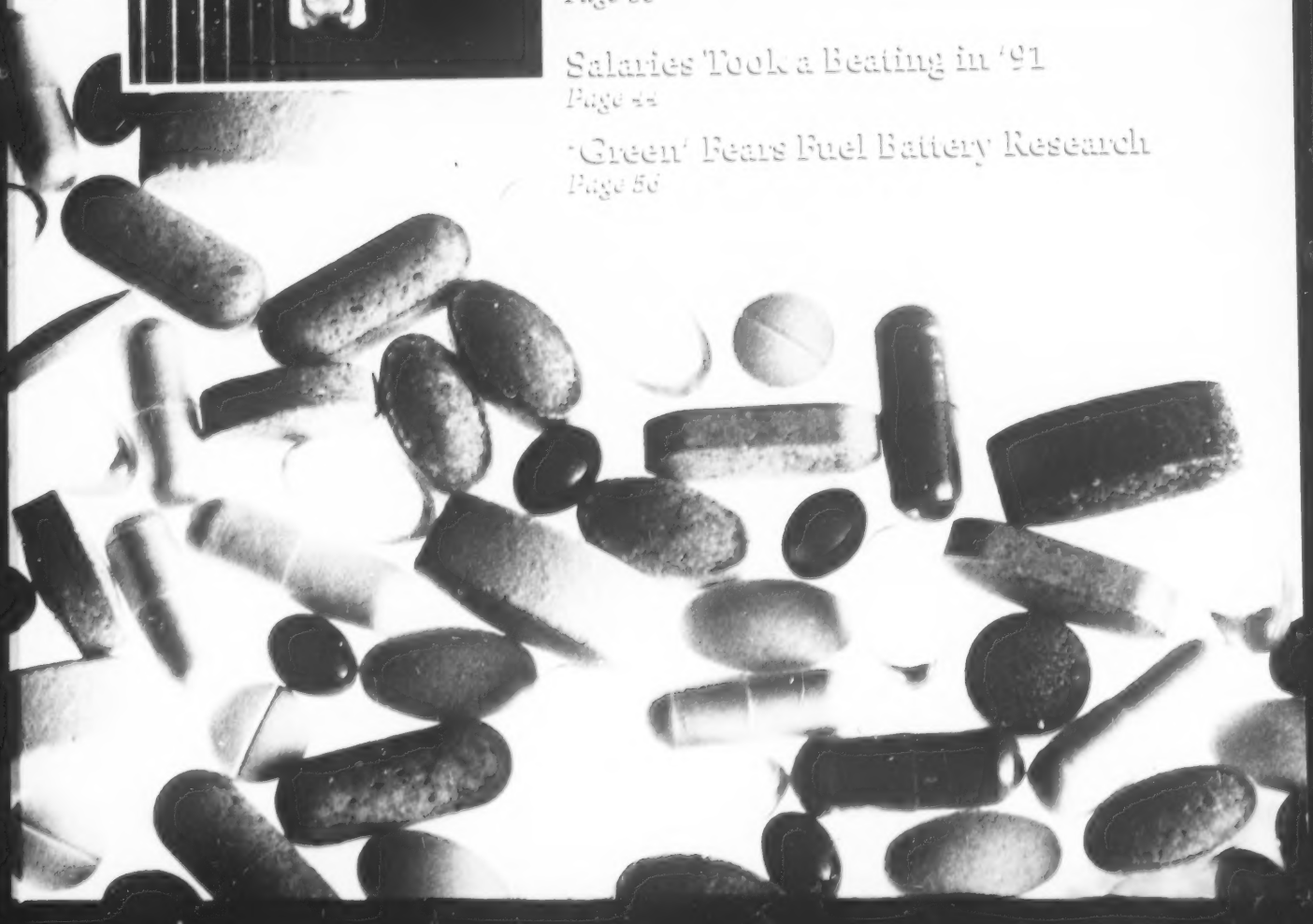

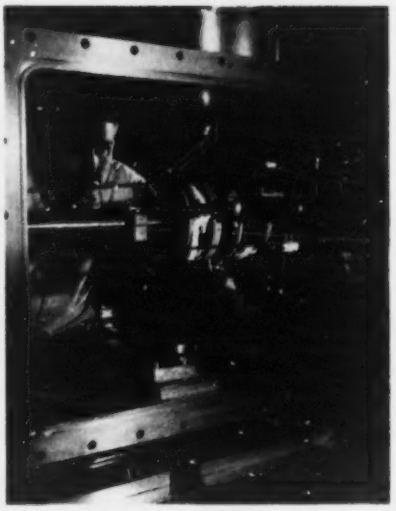

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R&D

The International Magazine of Research and Development

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ABOUT THE COVER "Pharm" cows sired by Herman, the first transgenic dairy calf, could become a plentiful source for human lactoferrin. See article, page 36. *Photo: GenPharm International.*

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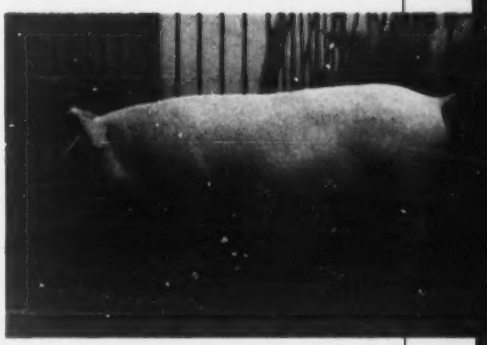

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New Arc Method Could Spark Shift to Vacuum Coatings 63

Anodic vacuum arc deposition applies fine-grained metallic films fast and could help dethrone electroplating as the dominant technology.

R&D BUSINESS

Flash Chips Become Enabling Technology

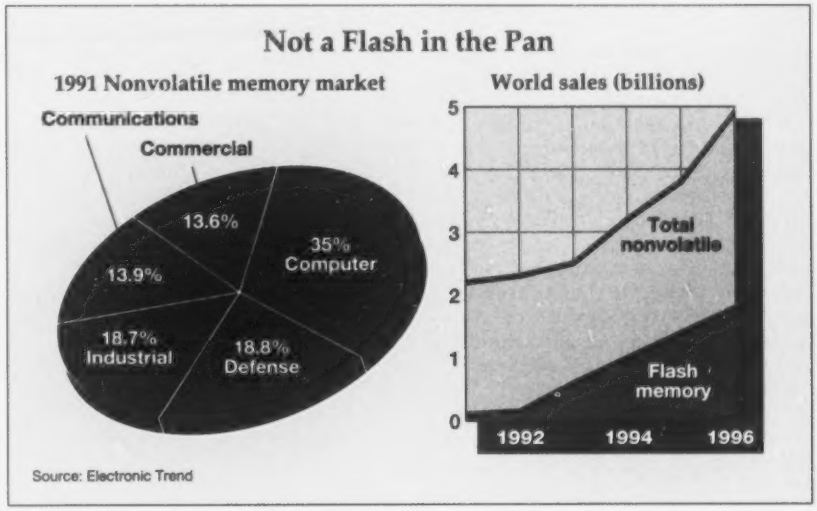
Rapid market growth for flash memory devices is expected following both price reductions and data storage increases by the Memory Components Div. of Intel, Folsom, CA. Intel is the market leader in flash devices with about 85% of the world market.

Flash chips are solid-state computer memory devices that are simpler in construction than current DRAM chips used as volatile computer memory. Flash chips, however, are nonvolatile devices that store data indefinitely, without a battery backup, yet can be easily erased and reprogrammed. Intel recently announced a $29.90 price for an 8-Mbit flash chip, making it comparable to current DRAM prices in costs/Mbit.

The flash memory price reduction, however, means that they still are about six times as expensive as comparable hard disk systems. Disk systems will be around for a while longer, since disk researchers are continuing to increase their capacity with development of new materials and thin-flim processing systems.

Compared to disk memory systems, flash chips are more rugged, smaller, and use less power. These characteristics will drive flash chip use in embedded applications, such as disk controllers, laser printers, robotics, medical instruments, and military/avionics. These applications will expand the production capabilities for flash devices and drive the lower costs that will allow them to compete against conventional storage systems.

Intel's current flash chips are based on 0.8-μm manufacturing technologies. Intel's recently announced joint venture with Sharp Corp., Tokyo, is expected to develop the next generation of flash memory devices based on 0.6-μm technologies. —*Tim Studt*



***Current interest** in nonvolatile memory devices is based on their capacity to replace optical or magnetic disk drives in portable computers.*

Foreign Firms Use More Technologies

Foreign-owned or affiliated (FOA) plants in the U.S. use a wider range of advanced manufacturing technologies than do U.S. manufacturers, according to a recent study by researchers at Rensselaer Polytechnic Institute, Troy, NY.

The study is based on manufacturing technology survey data made by the U.S. Bureau of the Census. This data included information on the use of technologies, such as CAD, lasers, robotics, and sensor inspection, in more than 10,000 U.S. plants.

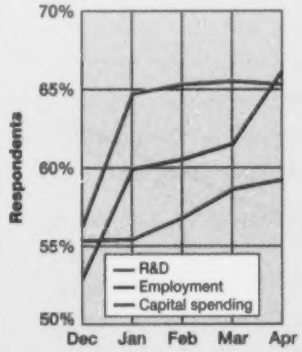
"Investment in new equipment per worker also is much higher in FOA plants than in domestic plants," says Show-Ling Jang, co-author of the study. "It ranges from 65% for computer manufacturers to 400% for higher investments [telephone manufacturers]." □

Business continues

Biotech Drives Bioreactor Growth

The global market for bioreactors is forecast to grow about 18% annually to just over $200 million by 1996, according to Strategic Directions Intl., a Los Angeles-based consulting firm.

This growth will satisfy bioreactor demand by biotech, pharmaceutical, and other industries. Pilot-scale bioreactors account for nearly 80% of the total market.



Employment Improves

An improving economy increased confidence in the general employment situation in April, according to a survey by Cahners Economics, Newton, MA.

Almost two-thirds of the executives surveyed said they would increase or maintain employment over the next several months. Confidence in R&D stayed about the same as in March.

Researchers' Salaries Took A Beating in '91

R&D's survey shows that in most cases, scientists and engineers got skimpy raises—if any at all.

By John Morkes, Associate Editor, R&D Magazine

Compensation packages are like politics: Everyone has an opinion. And, as with politics, a large-scale discussion about compensation can arouse a wide spectrum of feelings, from contentment to contentiousness.

The 4,984 respondents to *R&D Magazine's* annual salary survey made sure the entire spectrum was covered.

"My compensation package is perfect," said a corporate executive who makes more than $100,000 a year and received more than five weeks of paid vacation last year.

"I feel exploited, overworked, poorly utilized, mismanaged, and undercompensated," said an electrical engineer who makes less than $55,000 and did not take all three weeks of his paid vacation.

Most respondents were somewhere between the executive and the engineer, in terms of being satisfied with their salaries and benefits. Unfortunately, due to tight employer budgets, more respondents seemed to identify with the engineer.

One important reason is that 17.4% of the scientists and engineers surveyed received no raise at all in 1991, compared with 11.2% the year before (see "Salary Increases" chart). And in many cases, those who received raises got a smaller percentage increase than in previous years.

Also, many employees were frustrated to learn that though they would receive salary increases, they would have to wait longer than usual for the raises.

"The period between pay raises has stretched out to between 18 and 24 months," a nuclear engineer said.

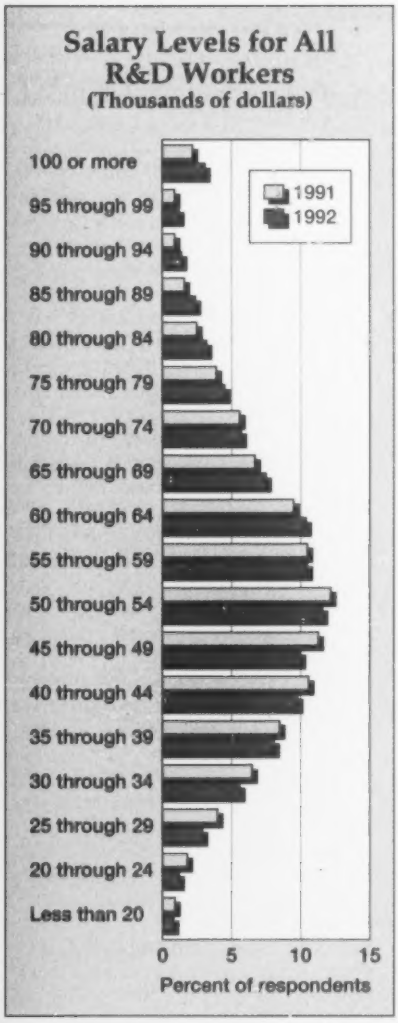
"Salary increases are deferred during tough times. Why isn't the time between raises ever shortened in good times?" asked a chemical engineer.

However, not everyone fared poorly in 1991. Physicists once again topped the list with the highest median salary—$57,772—with nuclear engineers and aeronautical engineers close behind (see "Rankings" chart).

Forty-seven percent of the respondents' salary increases were above the 1991 inflation rate of 4.3%, as determined by Cahners Economics, New-

R&D Salary Survey: How Do You Measure Up?

All Researchers Compared	1991 Salary Raise Percentage (Percent of respondents)						1992 Salary Median	With Present Employer Median (years)	Age Median (years)
	Zero	< 2%	2–5%	6–9%	10–13%	≥14%			
Aeronautical engineer	8.5	—	70.7	14.6	4.9	1.2	$57,341	13.2	48.2
Biotech/biologist	22.4	2.1	43.6	21.5	7.5	3.0	50,000	9.0	42.4
Chemical engineer	12.4	0.3	48.7	28.7	7.9	2.0	55,090	8.2	40.1
Chemist	13.7	0.8	47.8	28.2	7.1	2.3	51,550	9.0	41.6
Electrical engineer	21.4	2.3	47.3	20.0	5.8	3.0	52,045	7.6	41.7
Geologist	25.0	2.1	52.1	12.5	6.3	2.1	44,390	12.3	43.4
Industrial engineer	25.0	1.7	56.7	13.3	—	3.3	45,850	9.3	42.4
Materials	22.7	—	47.4	23.8	5.0	1.1	55,726	8.6	41.1
Mathematician	18.2	—	59.1	9.1	9.1	4.5	50,009	15.0	47.0
Mechanical engineer	19.2	0.6	48.0	23.8	4.8	3.5	51,380	7.7	40.6
Nuclear engineer	5.6	2.8	66.7	22.2	—	2.8	57,470	12.5	45.7
Physicist	17.7	0.6	50.7	24.1	6.1	0.9	57,772	8.3	43.9



Salaries for R&D workers in 1992 are about the same or slightly higher than salaries in 1991 (left), according to nearly 5,000 survey respondents.

ton, MA (see "Salary Increases" chart). That's an improvement over 1990, when 43.9% beat inflation, and 1989, when the figure was 46.5%.

A minority of respondents had positive things to say about their compensation packages.

"The benefits and job security are great, the salary is enough to live on, and the work is exciting and interesting," said a government geologist.

"Our 'cafeteria' benefits plan is nice. Credits that are not used are paid as taxable income," an industrial chemist said.

Other comments were positive, but mixed with concern.

"My compensation package is so good that it may be cut back to save the company money," said a mechanical engineer.

Most comments, however, were negative and covered a range of subjects. A common complaint was that the respondents are overworked and underpaid.

"I receive low pay and no recognition for significant results and for taking on extra work," said an industrial chemist.

"During this age of 'doing more with less,' you pay the price for using vacation time. By the time you spend copious amounts of unpaid overtime to allow yourself to take vacation, you are so mentally and physically drained that you spend the vacation recovering. I feel more like an indentured servant than the internationally known professional that I am," said an industrial engineer.

Respondents also complained about the way raises are meted out.

"How raises are determined is vague, arbitrary, and mysterious," a materials researcher said.

"Raises do not depend on merit. Only across-the-board raises are given unless you threaten to quit," said a chemist.

"Evaluation for increases is based more on publication numbers than substantive production," said a university professor.

Blame for inadequate compensation was often laid on incompetent managers.

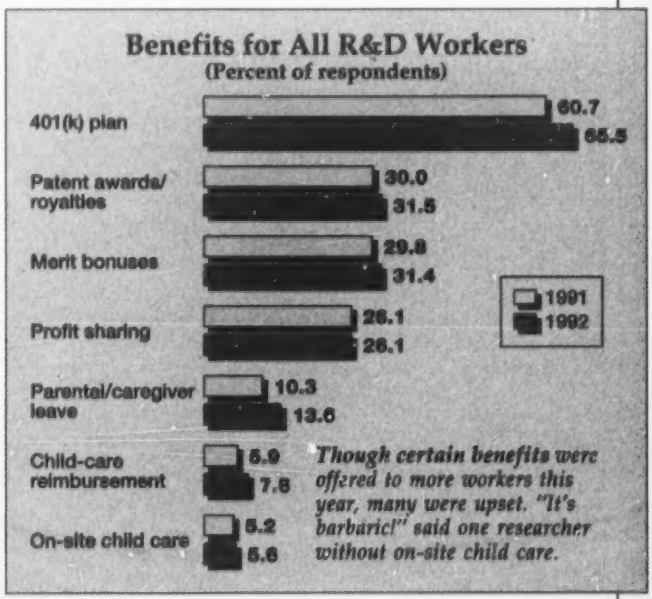
"Compensation is being cut to pay for management's mistakes," said an electrical engineer.

"If we had competent management, we would make more profits and be able to afford better annual increases," another electrical engineer said.

Many researchers said that if they have to suffer poor compensation, then their bosses should, too.

"My compensation is shrinking fast, but top management doesn't get hit as hard—they receive fat bonuses,"

Experience Median (years)	Highest Academic Degree (Percent) <BS	BS	MS	PhD
23.5	3.6	32.5	47.0	16.9
16.2	1.8	18.1	21.7	58.5
13.4	5.4	33.5	34.1	26.0
14.5	4.9	34.2	19.2	41.7
13.2	15.8	32.3	35.7	16.2
17.1	4.1	16.3	34.7	44.9
10.9	36.7	38.3	16.7	8.3
15.1	7.7	23.7	29.2	39.4
19.2	4.5	27.3	45.5	22.7
13.7	14.2	41.8	31.3	12.7
21.0	2.8	25.0	22.2	50.0
17.9	4.3	16.3	26.0	53.4



Though certain benefits were offered to more workers this year, many were upset. "It's barbaric!" said one researcher without on-site child care.

'I never have to worry about the possibility of overcompensation,' a toxicologist said.

said a mechanical engineer.

"The executives get the big bonuses, good times or bad. We get the squeeze," said a materials researcher.

"The bonuses given to top management are too large. The money would be better spent if they gave larger incentives at the lowest levels," a chemical engineer said.

Some respondents felt that they are compensated less than other researchers for the same type of work.

"My overall salary is about half what I would expect for a similar job in industry," said a university chemist.

"If I were a man rather than a woman, I would be making several thousand more annually," an industrial hygienist said.

"After age 50, we are 'locked in' to retirement and get lower raises for the same responsibilities as younger workers," said a government chemical engineer.

Another subject of complaint was benefits, whose costs are being paid more by the employee and less by the employer, respondents said.

"It seems that every time the company makes 'improvements' to the benefits package, it ends up costing me money," said a nuclear engineer.

Salary Increases for All R&D Workers*
(Percent of respondents)

Increase amount	1992	1991	1990
None	17.4	11.2	9.2
Less than 2%	0.9	0.9	2.1
2 through 5%	48.5	50.3	54.9
6 through 9%	24.6	27.2	24.7
10 through 13%	6.2	7.2	5.9
14% or more	2.4	3.2	3.2
Ahead of inflation	47.0	43.9	46.5

*Granted in year preceding that shown

A whopping 17.4% of researchers missed out on raises last year, while others received smaller increases than usual. Often, employees found their raises delayed several months.

Many researchers were unhappy that their employers did not offer "cafeteria-style" benefits packages that let employees choose their own benefits, up to a certain dollar amount.

Other respondents were critical of such a plan.

"We are shifting to a flexible benefits program. While this will result in great savings for the company, it will probably cost me about $1,100 a year. This would reduce my 5.1% salary increase to 3%," said an industrial chemist.

The subject of health insurance generated angry comments because of high cost to the employee, low coverage, and other reasons.

"Our health insurance program is so poorly defined that you must get sick to determine what it covers," said a university biologist.

A few respondents worried that their retirement and pension benefits might not be adequate down the road.

"With corporate buyouts and job security being what it is today, I will never see a pension or retirement check other than that which I provide for myself through 401 (k) and IRA plans. Who knows about Social Security in 20 years?" said an industrial chemist.

Some researchers gave the impression that U.S. companies are no place for civilized scientists and engineers to work.

"My company has no on-site child care. It's barbaric!" a materials researcher said.

"Vacation policies in the U.S. stink. Any other civilized country gives more vacation," said an industrial chemist.

Several respondents showed they have a sense of humor about their compensation. When asked "What do you like best about your compensation package?" an industrial technician answered, "The paychecks don't bounce."

A government toxicologist answered, "I never have to worry about the possibility of overcompensation, and my lifestyle never makes my neighbors jealous." R&D

Copies of R&D's *complete Salary Survey, with results presented in 71 tables, are available for $150 each from Joan Cacioppo,* R&D Magazine, *1350 E. Touhy Ave., Des Plaines, IL 60018; phone: 708/390-2734; fax: 708/390-2618.*

Rankings by Median Salaries

Rank 1992	Rank 1991	Profession	Median Salary 1992	Median Salary 1991	Percent Change
1	2	Physicist	$57,772	$58,062	−0.5
2	5	Nuclear engineer	57,470	55,010	4.5
3	1	Aeronautical engineer	57,341	58,333	−1.7
4	7	Materials	55,726	54,107	3.0
5	6	Chemical engineer	55,090	54,750	0.6
6	8	Electrical engineer	52,045	54,030	−3.7
7	9	Chemist	51,550	51,794	−0.5
8	11	Mechanical engineer	51,380	49,578	3.6
9	3	Mathematician	50,009	56,666	−11.7
10	10	Biotech/biologist	50,000	49,838	0.3
11	12	Industrial engineer	45,850	43,636	5.1
12	4	Geologist	44,390	55,500	−20.0

READER RESPONSE PANEL

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R&D SOFTWARE

Chemical Reaction and Equilibrium Computations

The Windows version of HSC software offers a quick and easy way to solve chemical reaction problems with a personal computer. All calculations utilize an automatically integrated thermochemical database that includes more than 5,600 compounds. The software helps to avoid expensive trial-and-error chemistry, allowing the chemist or engineer to set up optimum reaction conditions for experiments.
Outokumpu Research **Circle 342**

Collecting Weighing Data

BalanceTalk Jr. is a memory-resident (TSR) software program for collecting weighing data. The MS-DOS program transfers balance data into almost any other program. It works with all of the company's balances having a unidirectional interface. Setup is part of the program, so there is nothing to configure. The user simply loads the program and begins collecting weight data from the balance.
Mettler **Circle 344**

Spectroscopy Upgrade

Version 3.10 of the DM3000 spectroscopy software offers new features such as expanded control of the company's products, including skip scan on QuikScan diode arrays, image storage, and gray scaling for Spectrum One CCDs, support of the Fluoromax and the 270M spectrometer. New laser printer and mouse capabilities have been added.
SPEX Industries **Circle 343**

CE Control

SpectraPHORESIS software for capillary electrophoresis control is now available for other IBM-PC compatible computers. The new software will run on the Spectra 386 computer, giving users of the company's Analytical CE greater flexibility in their choice of computers. It controls the CE and provides method control and data reduction for CE analysis.
Spectra-Physics **Circle 341**

Free PC System Configuration Tool

DAQ Designer is the first computer-aided system configuration tool for PC-based data acquisition. It is an interactive and easy-to-use package with a graphical user interface that asks the user questions about system requirements, and then recommends specific plug-in data acquisition boards, signal conditioning products, cable assemblies, and software packages that can be used to develop the desired data acquisition system. And best of all, it's free.
National Instruments **Circle 340**

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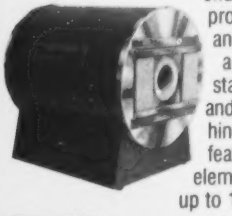

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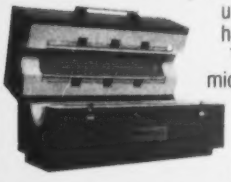

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